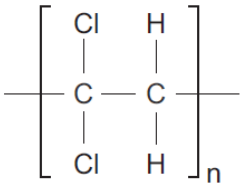
GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource A

Organic Chemistry and Analysis

1. Give the **name** of the monomer that is used to produce the polymer shown below. [1]



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2. Give the structure of a product obtained when 1,4-dimethylbenzene is oxidised by alkaline potassium manganate(VII) and acidified. [1]

3. The boiling temperatures of three compounds of formula $C_3H_8O_2$ are given in the table.

Compound		Boiling temperature / °C
L	$CH_3–CH_2–O–O–CH_3$	40
M	$CH_3–O–CH_2–O–CH_3$	42
N	$HO–CH_2–CH_2–CH_2–OH$	214

Suggest why the boiling temperature of compound **N** is considerably higher than the boiling temperatures of the other two compounds, illustrating your answer by means of a diagram. [2]

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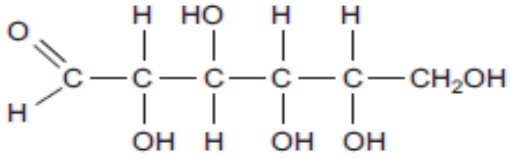
4. The willow tree has been used for hundreds of years to obtain substances with medical benefits. One of these substances is salicin, which shows analgesic and anti-inflammatory properties.

Salicin is a molecule that consists of two parts – one based on glucose and the other on (2-hydroxyphenyl)methanol, $C_6H_4(OH)CH_2OH$.

(a) The formula of glucose can be written as an open-chain formula.



Glucose is a reducing sugar and will react with Fehling's reagent.

State what is seen in the test with Fehling's reagent and identify the group present in glucose that is responsible for this reaction. [2]

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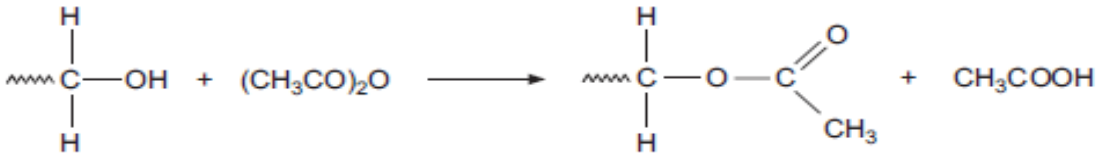
(b) An outline of the method used to make glucose pentaethanoate is shown below.

- 0.015 mol of glucose is placed in a flask with a large excess of ethanoic anhydride.
- The mixture is heated under reflux at 100 °C for one hour.
- The product is cooled and poured into a beaker containing crushed ice.
- After stirring and allowing the ice to melt, the mixture is filtered.
- Ethanol is then used to recrystallise the glucose pentaethanoate.

(i) In this reaction the —OH groups in glucose react with ethanoic anhydride to give ethanoate groups.



State and explain the minimum number of moles of ethanoic anhydride used in this reaction. [2]

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(ii) Briefly outline how the mixture could be 'heated under reflux at 100 °C'. [2]

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(iii) State how the method implies that glucose pentaethanoate is insoluble in water. [1]

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(iv) During recrystallisation glucose pentaethanoate is dissolved in the 'minimum quantity of hot ethanol'.

Why was the '**minimum** quantity' used? [1]

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(v) The melting temperature of glucose pentaethanoate is 134 °C. In the experiment the sample is found to melt at a lower temperature.

Suggest a possible cause for this lower value. [2]

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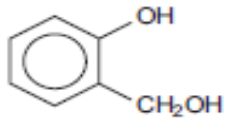
(c) Ethanol can be made from glucose by fermentation.

$$C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

In an experiment 0.200 mol of glucose was dissolved in water and fermented using yeast. At the end of the reaction all the glucose had been converted into ethanol and carbon dioxide. If the volume of the resulting solution was 2.03 dm^3, calculate the concentration of ethanol in g dm^{-3}. [3]

Concentration = ... g dm^{-3}

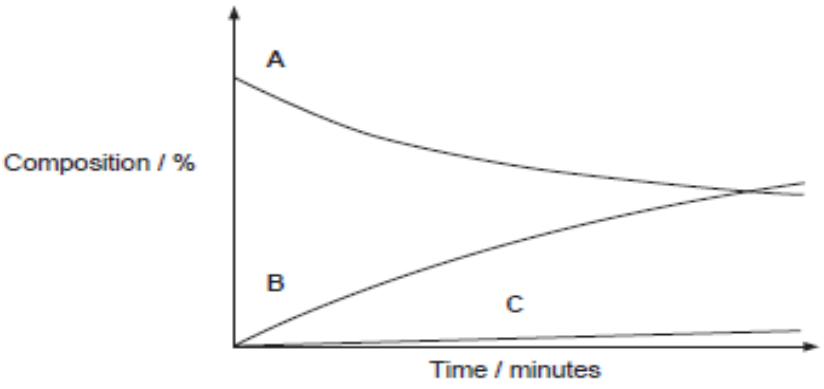
(d) The other product from the breakdown of salicin is (2-hydroxyphenyl)methanol – compound **A** below.

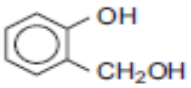


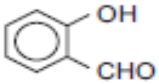
compound **A**

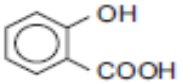
Compound **A** is both a phenol and an alcohol and oxidation of the alcohol group results in a number of other products, including compounds B and C. Both of these compounds have important commercial uses and a method that gives them in high yields is desirable.

In one method, compound **A** is oxidised at 50 °C using water as the solvent.
The graph shows the composition of the resulting mixture.



A


B


C


(i) State how the quantity of compound **A** present in the mixture changes over time. [1]

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(ii) Comment on the proportion of compounds **B** and **C** in the mixture as the reaction proceeds. [1]

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(iii) The proportion of products present was found using HPLC.

Calculate the percentage of compound **A** oxidised after 15 minutes. [1]

	Concentration / mol dm^{-3}	
Compound	Start	After 15 minutes
A	0.20	0.02
B	0.00	0.10
C	0.00	0.01
other products	0.00	0.07

Percentage oxidised = ... %

(iv) Compounds **A**, **B** and **C** are colourless and were detected during HPLC by using ultraviolet radiation.

Absorption maximum / nm	Compound
202.1	**C**
212.2	**B**
273.4	**A**

State, giving a reason, which of these three compounds has the absorption maximum of the highest energy. [2]

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(v) This oxidation can also be carried out using benzene as the solvent.
Compound **B** is the only product and the rate of oxidation is higher than when using water as the solvent.

Give a reason why the method using water is seen as a 'greener' process. [1]

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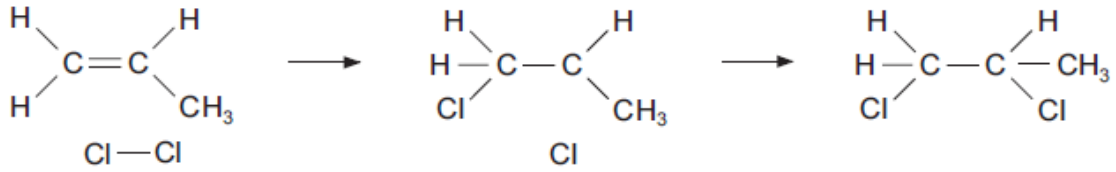
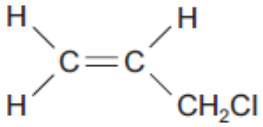
5. *(a)* At room temperature propene reacts with chlorine by electrophilic addition.

Complete the mechanism for this reaction. [2]



(b) At 500 °C propene reacts with chlorine via a radical mechanism to give 3-chloropropene together with hydrogen chloride.



3-chloropropene

Describe a simple chemical test to distinguish between 1,2-dichloropropane [formed in part *(a)*] and 3-chloropropene. Give the reagent and the result with both compounds. [2]

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(c) (i) 3-Chloropropene can be converted to prop-2-en-1-ol by reaction with sodium hydroxide in a nucleophilic substitution reaction.

$$CH_2{=}CHCH_2Cl + NaOH \longrightarrow CH_2{=}CHCH_2OH + NaCl$$

Give the formula of the nucleophile used in this reaction. [1]

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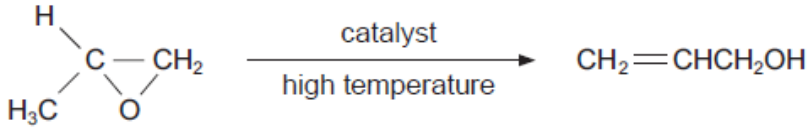
(ii) An alternative method of obtaining prop-2-en-1-ol is by the rearrangement of epoxypropane.



When choosing an appropriate method there are a number of factors to be considered.

Suggest **two** factors that should be considered if prop-2-en-1-ol is to be produced from epoxypropane rather than by the method described in part (i). [2]

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2. .....

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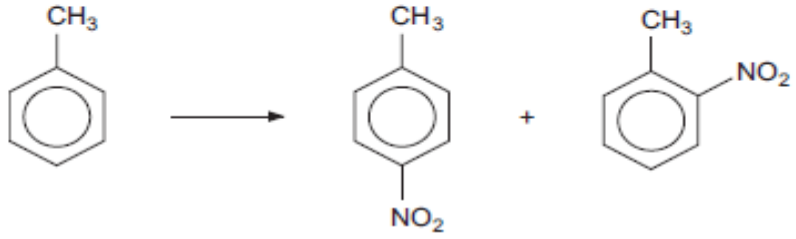
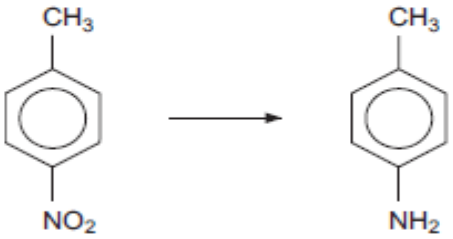
(d) Creosote is a pale yellow liquid that is used as a wood preservative. This material is largely a mixture of various phenols, including 4-methylphenol.

(i) In the laboratory 4-methylphenol can be made in several stages from methylbenzene.

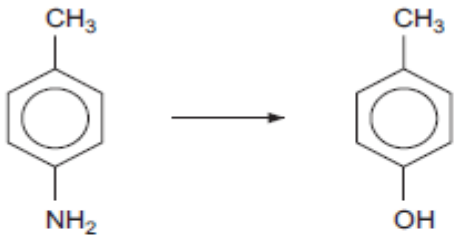
First stage The nitration of methylbenzene



Second stage The reduction of 4-nitromethylbenzene



Third stage Making 4-methylphenol from the amine 4-methylphenylamine



I. Write the mechanism for the formation of 4-nitromethylbenzene, starting with methylbenzene and the nitronium ion. As part of your answer you should state the reagents used to generate the nitronium ion and name the type of reaction mechanism occurring. [4]

Reagents used .....

Type of reaction mechanism .....

II. Suggest a suitable reducing agent used to produce 4-methylphenylamine from 4-nitromethylbenzene. [1]

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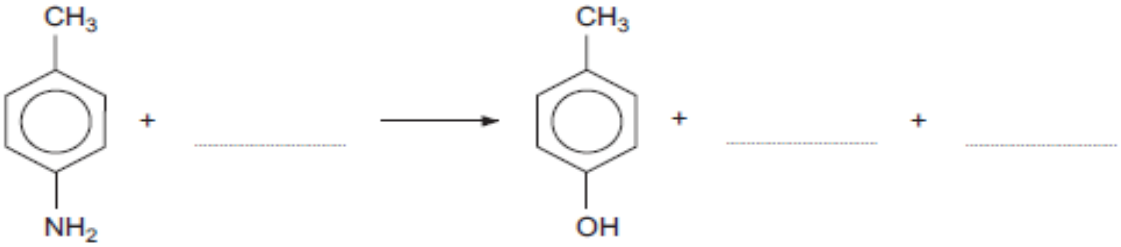
III. Complete the equation below which shows the production of 4-methylphenol from 4-methylphenylamine. [2]



(ii) pK_a is a term used to express the acidity of organic compounds. The lower the value, the greater the tendency for the compound to lose a hydrogen ion, making it more acidic.

The table shows the pK_a values for some compounds.

Compound	pK_a
ethanoic acid	4.8
4-nitrophenol	7.2
phenol	9.9
4-methylphenol	10.2

I. Ethanoic acid is more acidic than phenol. State a chemical test that you could use in the laboratory to show this difference in acidity. You are given aqueous solutions of each compound. [2]

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II. Suggest why 4-nitrophenol is much more acidic than phenol. [1]

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